April 25, 1967 R. L. JAESCHKE 3,316,429

INDUCTOR DRUM AND SUPPORTING CONSTRUCTION FOR ELECTROMAGNETIC MACHINES

Filed Feb. 3, 1964 2 Sheets-Sheet 1

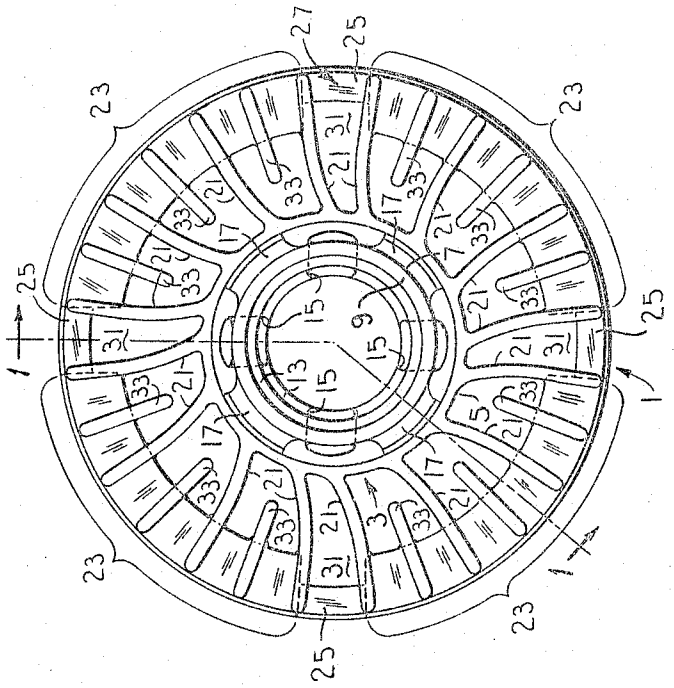


FIG. 2.

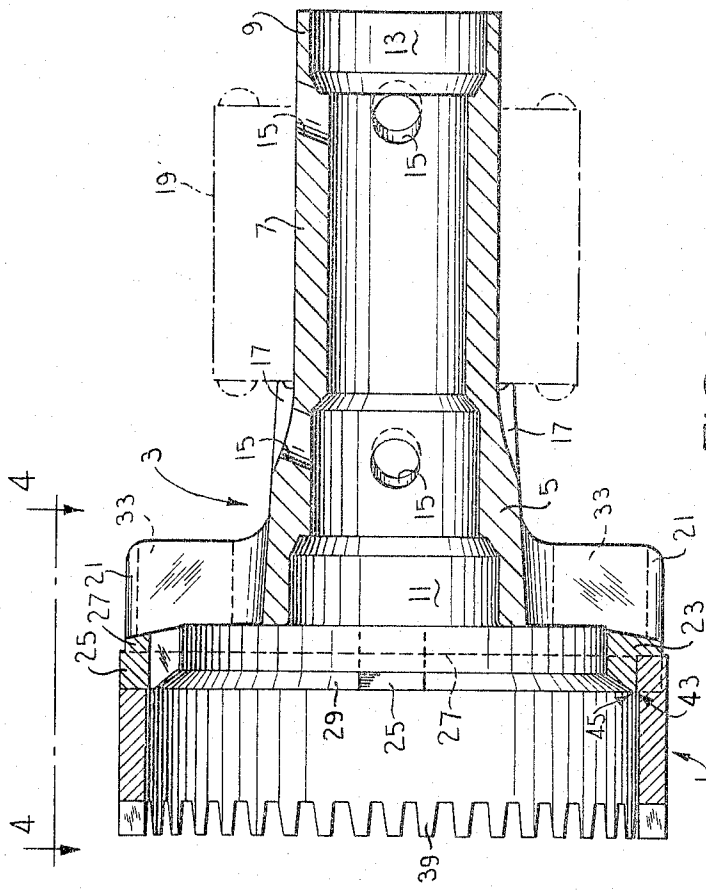


FIG. 1.

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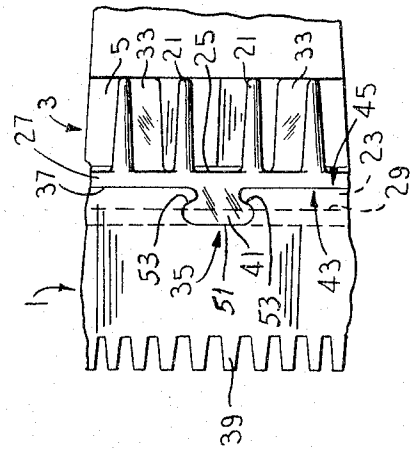


FIG. 4.

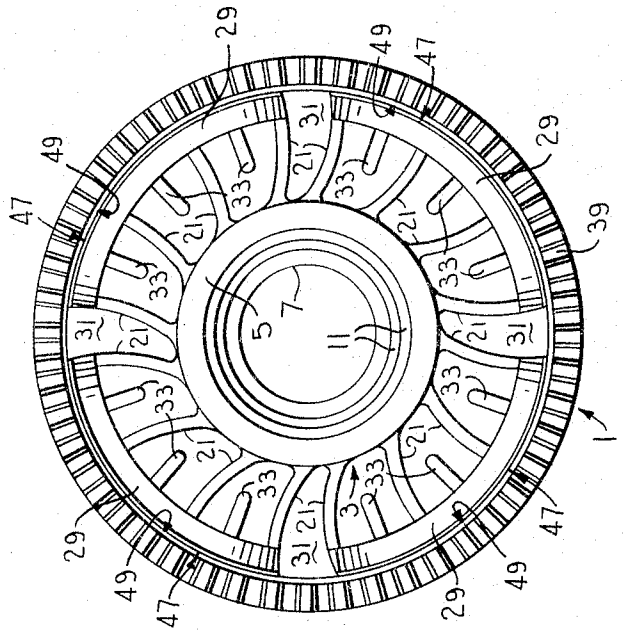


FIG. 3.

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3,316,429

INDUCTOR DRUM AND SUPPORTING CONSTRUCTION FOR ELECTROMAGNETIC MACHINES

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9 Claims. (Cl. 310—93)

This invention relates to an inductor drum and supporting construction for electromagnetic machines in general, and with regard to certain more specific features, to an integral construction of this type for use in eddy-current clutches, brakes, dynamometers and the like in which inductor or other drums are likely to run hot.

Among the several objects of the invention may be noted the provision of an improved integrated form of drum and supporting construction in which the drum and supporting components are strongly connected; the provision of a construction of the class described in which an aluminum or other light metal quill is attached directly to a drum of another material such as iron or steel by means which can be carried out with substantial manufacturing savings and a reduction in weight; and the provision of an improved connection between a comparatively light-weight quill of one metal such as aluminum and a drum such as of iron or steel which allows for certain stress-relieving compensating action between the drum and the quill under differential heating thereof encountered in operation. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of which will be indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

FIG. 1 is an angled, axial section of an inductor drum and quill construction, viewed on line 1—1 of FIG. 2, the broken lines illustrating how the rotor and a motor rotor are carried on the quill part;

FIG. 2 is a right-end elevation of FIG. 1;

FIG. 3 is a leftend elevation of FIG. 1; and

FIG. 4 is a fragmentary plan view of parts at the left end of FIG. 1, being viewed from line 4—4 shown on the latter FIGURE.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

The terms iron and aluminum, as used herein, include their alloys, respectively.

Typical but not the only apparatus to which the invention applies is disclosed, for example, in my U.S. Patents 2,856,854, 2,606,948 and 2,702,872. These relate to electromagnetic clutches in which inductor rotors may run hot, but the invention is applicable to any machines such as brakes, dynamometers and others in which a rotor may run hot. The following description will, for purposes of illustration, be that of such a construction for use in a type of electromagnetic clutch in which an eddy-current drum is employed and which is required to be mounted upon a quill which supports the rotor of the motor which drives the clutch. Since the invention concerns only these parts, other conventional parts of such a clutch are not shown, as for example the casing, polarized field member and other cooperating parts.

Referring now more particularly to the drawings, there is shown at numeral 1 a magnetizable inductor drum

composed, for example, of iron or iron alloy such as steel. It is formed by rolling from a flat strip, after which abutting ends of the strip are welded to form a ring-shaped drum. Suitable machining may be employed to provide circularity. Before rolling, the sides of the strip are notched by punching in a manner and for purposes to be described. As is known, drums in eddy-current couplings, brakes and dynamometers or the like surround a field pole member which, when its field is excited, produces a polarized magnetic field which sweeps relative to the drum, so that upon relative rotation one drives the other. Since the drum is comparatively heavy, it is desirable that its supporting structure shall be as light as possible. Since it is not required, and in fact undesirable, that the supporting structure shall be magnetizable, it becomes desirable that it be made of aluminum, aluminum alloy or other light nonmagnetizable metal. At numeral 3 is shown such a supporting structure in the form of a quill for the drum 1. It is to be understood that the quill form of support is one form only of others that might be used. Heretofore such quills or the like were made of iron and peripherally brazed marginally to drums such as 1. This was not only a costly procedure but resulted in a heavy drum-and-quill unit and, in view of the manner in which the rims of the quill and drum were joined, caused thermal stresses upon differential heating. For example, it is not uncommon for an inductor drum of the type herein described to reach a temperature of 600° F., while the quill remains comparatively cool. This causes relative expansions between the quill and drum and stress problems at the connection therebetween.

The present quill, which is composed of cast aluminum, has a hub section 5 from one side of which extends a tubular sleeve section 7. The hub section contains a counterbore 11 for the reception of the outer race of the usually employed ball or like bearing. The inner race of this bearing supports the shaft of the field member which is to be located within the drum 1. The bearing, shaft and field member are not shown. The shaft extends through the sleeve portion 7 and out of the other end 9 of the latter, where the shaft is supported by the inner race of a second ball or like bearing, the outer race of which is carried in a counterbore 13. This bearing also is not shown. In short, the shaft and the field member (not shown) are supported by bearings (not shown) in the quill 3. It will be understood that the counterbores 11 and 13 may be formed to accept ordinary sleeve bearings, instead of outer races of ball or like bearings, if desired. Openings 15 in the quill are provided for air circulation in the known manner.

Adjacent to the sleeve 7 the hub 5 is exteriorly provided with projections 17. The broken lines indicated at 19 in FIG. 1 indicate the rotor of a typical a.c. motor for driving the quill. This rotor is press-fitted on the sleeve 7. The inward side of this rotor is provided with members that interlock with the projections 17. The aluminum, being comparatively soft, lends itself to a tight locking action to prevent any rotary slip of the rotor 19 on the sleeve 7.

Extending from the hub 5 are four groups of four each, preferably curved, cooling fins 21. These form four groups of radial supports or spokes which support four comparatively wide peripheral segments 23. These segments 23 are joined by comparatively narrow connections 25. Thus the segments 23 are radially wider than the connections 25. Together they form an annular ring which is numbered as a whole as 27 (FIG. 1). The wide segments 23 extend into the drum 1 and are beveled at their inner arcuate ends, as shown at 29. In view of the above, it will be seen that the ring 27 is exteriorly

continuous but interiorly notched, as shown at 31, by reason of the narrow connections 25 between the segments. The notches 31 may be formed during the casting process to be described, or may be made by a milling or other machine operation. Extending inwardly from each segment 23 is a group of three cooling fins 33 which interdigitate with the spoke-forming fins 21. Both sets of fins 21 and 33 act as centrifugal fan blades for circulating air outwardly as the device rotates, but the fins 33, unlike fins 21, form no support for the segments 23. Thus the fins 33 are supported on the segments 23 and the latter are supported by the fin-forming spokes 21.

As above stated, the drum 1 is composed for example of steel, and the remaining parts of the quill are composed for example of di-cast aluminum. There thus exists a problem of making a proper connection between the aluminum and the steel, and this is accomplished as follows:

One margin of the strip is punched crosswise before rolling up the strip to form the drum, so as to provide integral axial cooling fins 39. The other margins of this strip, before rolling it up, is also punched to form fourteen equally spaced T-headed or keyhole locking slots or notches. These become locking slots or notches 35 on one end of the drum as rolled up. Since the sides of the notches as punched out of the originally flat strip are parallel, these sides flare outwardly in a radial direction after the strip is rolled up into drum form. To connect the drum 1 and quill 3, I have the drum 1 placed in a suitable recess in a diecasting mold. The remaining portion of mold is suitably recessed to die cast the quill parts integrally under pressure, including T-headed portions 41, the latter being cast into the T-headed radial slots 35 in the drum 1. The mold also allows the ring 27 to contact the end of the drum 1 and allows the outsides of the segments 29 to contact the inside of the right-hand end of the drum 1. When the parts 1 and 3 are removed from the mold, they are in assembled condition with lock-and-key connections formed between the radially flared T-headed slots 35 in the iron drum margin and the aluminum T-headed portions 41. It will be understood that while T-shapes are shown, other lock-and-key shapes may be used for slots 35 and the cast-in key parts 41. Abutting radially flat margins of the drum and of the cast quill parts are shown at numerals 43 and 45, respectively cylidrical or arcuate abutments are shown at 47 and 49 between the drum and quill parts, respectively.

It is to be noted that, by effecting the connection between the drum 1 and the quill 3 by diecasting the quill thereon, close interconnecting fits are obtained between the lock and key shapes at 35 and 41, axial abutments at 43, 45, and the radial abutments at 47, 49. But there are no metallurgical bonds at these fits such as are obtained by brazing, welding, soldering or the like. Thus under differences of temperature between the drum 1 and the quill 3, stress-relieving effects occur at the interfaces of abutting parts. Thus localized high stresses are avoided at these points. Nevertheless, the drum and the quill are interlocked into a strong permanent coaxial relationship. The interlocking casting process, and more particularly a die-casting process, reduces manufacturing costs. The lock-and-key devices establish and maintain true axial relationships between the drum and quill. The interfits of the inwardly projecting portions of the segments 23 establish and maintain radial relationships between the drum and quill.

The T-headed interlocking shapes at 35 and 41 (FIG. 4) have additional advantages. When molten aluminum at 41, which is at approximately 1400° F., is forced under pressure into a keyhole 35 in the drum 1, it encounters relatively cold steel. Aluminum has a high rate of shrinkage. As this aluminum cools in contact with the steel it tends to shrink, relaxing at the surface indicated at 51 in FIG. 4, and to press tightly against the areas indicated at 53. In this way, a good heat-conductive connection is formed. On the other hand, when the machine incorporating the invention is used, the drum heats, imparting heat to the solidified aluminum at 41. Again, since the aluminum has a high coefficient of expansion, it will expand in the slot 35 in such a way that relaxation may occur in the areas 53, but with increase of pressure on area 51. Thus good heat conductivity is maintained under all operating temperatures.

It will also be apparent that as the molten aluminum shrinks upon cooling, it draws in radially and effects tight contact with the outwardly flaring surfaces of the slot 35. Thus a strong connection is maintained between the steel and the aluminum parts in the T-head or keyhole arrangements.

As regards the locations of the T-headed connections 35, 41 and their number, these are arbitrary. Most of these locations fall within the arcs occupied by the wide segments 23. One or more may fall within an arc occupied by a narrow segment 25, it being understood that a number of keyholes other than fourteen may be employed.

The term key describing forms of the parts at 35 and 41 is intended to cover any equivalent interlocking form.

In view of the above, it will be apparent that the invention provides for a low-cost, high-quality and lightweight drum and quill assembly adapted to precision manufacture of eddy-current clutches, brakes, dynamometers and other electromagnetic machinery having differential heating and stress problems involved in their designs.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An integral drum and supporting quill assembly for electromagnetic machines comprising a drum formed of iron and spacedly notched around one margin thereof, a quill formed of aluminum which is cast against said margin of the durm to form a continuous ring abutment with said margin and to form lock and key connections between the notches and cast material which extends from said continuous ring into the notches, and circular segmental portions extending from said continuous ring axially into the inside of said margin, said quill being formed with a hub portion and groups of spokes, each group extending therefrom to a part of the ring portion from which one of said segmental portions extends.

2. An integral drum and supporting quill assembly comprising a drum formed of iron and spacedly notched around one margin thereof, a quill formed of aluminum which is cast against said margin of the drum to form a continuous ring abutment therewith and lock and key connections with the notches, and circular segmental portions extending from said continuous ring and extending into the inside of said margin, said quill being formed with a hub portion and groups of spokes, each group extending therefrom to a part of the ring portion from which one of said segmental portions extends, said segmental portions including parts radially wider than those arts of the ring portion between them to provide open spaces in the ring portion between said groups of spokes.

3. An integral drum and supporting quill assembly according to claim 2, wherein said spokes are formed as curved cooling fins.

4. An integral drum and supporting quill assembly according to claim 3, including cooling fins extending radially inward from said segmental portions and interdigitating with said spokes.

5. An integral drum and supporting quill assembly according to claim 3, wherein said hub has a cylindrical

sleeve extending therefrom, and projections extending from the hub toward the sleeve for engagement with a rotor located on the sleeve.

6. An integral drum and supporting quill assembly for eddy-current machines comprising a magnetizable drum formed of iron punched to form spaced notches around one margin thereof, a quill formed of nonmagnetic material which is aluminum cast against said notched margin of the drum to form a ring abutment with the margin of the drum and to infill the marginal notches to form lock and key connections between the drum and the quill, circular segmental portions extending from said ring and extending into the inside of said margin, said quill being formed with a hub portion and groups of spokes, each group extending therefrom to a part of the ring portion from which said segmental portions extend, said segmental portions including parts radially wider than those parts of the ring portion between them to provide open spaces in the ring portion between said groups of spokes, said radially wider parts having fins extending inward toward but not to the hub portion and interdigitating said spokes.

7. An integral drum and supporting quill assembly according to claim 6, wherein said spokes are formed as curved cooling fins.

8. An integral drum and supporting quill assembly for electromagnetic machines comprising a drum formed of iron and spacedly notched around one margin thereof, a quill formed of aluminum which is cast against said margin of the drum to form a continuous ring abutment with said margin and to form key connections between the notches and cast material which extends from said continuous ring into the notches, and circular segmental

portions extending from said continuous ring axially into the inside of said margin, said quill being formed with a hub portion and groups of spokes, each group extending therefrom to a part of the ring portion from which one of said segmental portions extends, the notched portions of the drum which form said key connections being radially outwardly flared.

9. An integral drum and supporting quill assembly comprising an iron drum spacedly notched around one margin thereof, an aluminum quill cast against said margin of the drum to form a continuous ring abutment therewith and key connections in the notches, and circular segmental portions extending from said continuous ring and extending into the inside of said margin, said quill being formed with a hub portion and groups of spokes, each group extending therefrom to a part of the ring portion from which one of said segmental portions extends, said segmental portions including parts radially wider than those parts of the ring portion between them to provide open spaces in the ring portion between said groups of spokes, the notched portions of the drum which form said key connections being radially outwardly flared.

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